

A Skin Test Survey of Tularemia in a Montana Sheep-Raising County

ELIZABETH A. CASPER, M.S.P.H., and ROBERT N. PHILIP, M.D., M.P.H.

IN AN epidemiologic study of tularemia in Montana trappers (1), intradermal tests with an ether-extracted vaccine proved useful for identifying persons with delayed hypersensitivity to *Francisella tularensis*. Although skin tests and agglutination tests correlated well, the skin tests were more sensitive than the agglutination tests in identifying prior infection among occupationally exposed persons. Our study was undertaken to determine by skin tests the prevalence of past infection among residents of a sheep-raising county in Montana where tularemia cases have frequently been reported.

Garfield County, in eastern Montana, comprises an area nearly as large as the State of Connecticut but is sparsely populated, with less than one person per square mile. Ranching is the principal occupation, and the county ranks second in the State in production of sheep. There are 70 times as many sheep as people in the county. Jordan, the only town in the county—and currently advertised as the most isolated frontier town in the United States—has a population of 557. The remaining 1,424 inhabitants are scattered on ranches or farms.

Garfield County's average annual reported tularemia case rate of 5.23 per 10,000 population

is the highest in Montana (fig. 1). During the past 40 years, 58 cases have been reported, almost all by the one county physician, a man who has practiced medicine for that entire period in Jordan and is fully cognizant of the tularemia problem. The sources of infection in 71 percent of the reported cases was listed as tick bite or contact with sheep or rabbits. More than half of the cases occurred in men in the 30- to 59-year age group. Waterborne illnesses or death from tularemia have never been reported.

In 1964 an epizootic in sheep and an outbreak of human tularemia occurred (personal communication, 1964, from W. L. Jellison, retired parasitologist, Rocky Mountain Laboratory). The epizootic began during lambing season, which coincides with peak wood tick (*Dermacentor andersoni*) activity. Sheep losses ranged from 1 to 43 percent of the lamb crop on various ranches. Fewer losses occurred among ewes and yearlings. Selective serologic testing after the epizootic and again 6 months later demonstrated tularemia agglutinins in 101 of 179 ewes and yearlings. Twenty-one lambs tested had no antibodies against tularemia.

In other sheep epizootics in western United States and Canada, Rocky Mountain Laboratory investigators found few or no associated human cases (2), but in Garfield County 12 cases were disclosed. In one sheepshearing crew of 12, five persons had serologically confirmed tularemia. Seven other cases occurred among sheep ranchers. All were men of median age, about 40. Severity of illness ranged from a mild influenza-like syndrome requiring no medical care to typi-

Miss Casper and Dr. Philip are with the National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratory, Public Health Service, Hamilton, Mont. This paper was presented at the 23d annual meeting of the International Northwest Conference on Diseases in Nature Communicable to Man, held in Hamilton on August 19, 1968.

cal ulceroglandular tularemia requiring hospitalization. Sheepshearers in this outbreak apparently had a milder illness, with cervical adenopathy and chest pain as the principal symptoms, while most of the ranchers had ulcers and adenopathy involving an upper extremity.

Methods

Participation in the 1967 survey was requested, by letter, of all county residents 6 years old and older. Participation of residents with a known history of tularemia was not encouraged over participation of those without a history of the disease. To facilitate attendance, skin-test clinics were held in four areas in the county. Information on ranching activities and history of tularemia or tularemia-like illness following exposure to sheep or after tick bites was elicited from each participant before the skin test reading. Persons who were or had been sheep ranchers, sheephands, sheepshearers, or residents on sheep ranches were considered as having contact with sheep.

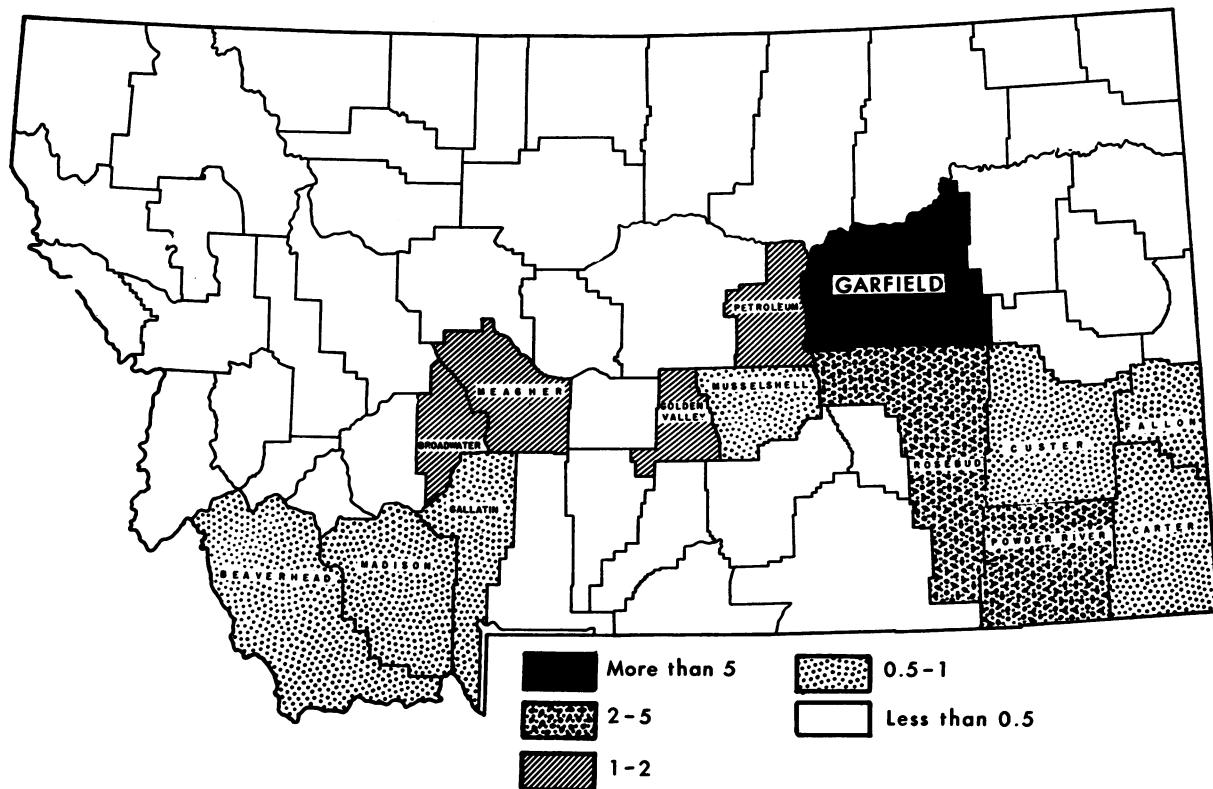
The skin-test antigen was Larson's ether-extracted tularemia vaccine (3), prepared in one

Table 1. Participation in the Garfield County tularemia skin-test survey, by age, sex, and place of residence, 1967

Characteristics	Population	Participants	
		Number	Percent
Total.....	1, 981	365	18. 4
Age (years):			
Less than 20.....	828	142	17. 2
20-39.....	452	80	17. 7
40-59.....	416	112	27. 0
60 and over.....	285	31	10. 9
Sex:			
Male.....	1, 079	194	18. 0
Female.....	902	171	19. 0
Place of residence:			
Town (Jordan).....	557	118	21. 2
County.....	1, 424	247	17. 3

lot in 1963 by Dr. Cora R. Owen, of the Rocky Mountain Laboratory, and lyophilized and stored at 4° C. until used. It was rehydrated with sufficient normal saline to give 2.5 precipitating units in the dilution used for testing, and 0.1 milliliter of this dilution was injected intradermally in the volar surface of the forearm. Readings were made at 48 or 72 hours by

Figure 1. Average annual tularemia case rate per 10,000 population, Montana, 1925-64



measuring the transverse diameter of erythema and induration. Induration of 5 millimeters or greater was considered a reaction (1).

Results

Three hundred and sixty-five (18 percent) of the county's 1,981 residents were skin tested. Twenty-six percent of the 592 households were represented by one or more members (4). The characteristics of the sample were similar to those of the county population in sex and in county to town ratio (table 1) but differed in age from the general population. Participation was highest in the 40- to 59-year age group and lowest in the 60 and over age group.

Twenty-four (6.6 percent) of 365 participants were reactors including 19 (9.8 percent) of 194 males and five (2.9 percent) of 171 females. The reactor rate in each age group, according to sex, is shown in table 2. Frequency of reaction was predominant among all males except those under 20 years old. The highest rate was noted among men 40 to 59 years old; this group included 54

percent of all reactors. No children under 10 reacted although 34 were tested.

Skin sensitivity was more frequent among persons having contact with sheep than among those without such exposure (table 3). Twenty (9.5 percent) of 211 persons who had worked directly with sheep or lived on sheep ranches were reactors, while only four (2.6 percent) of 154 persons without exposure reacted. This difference is statistically significant ($P < 0.01$) and was particularly evident in the 40- to 59-year age group. Nearly one of every five persons with sheep contact was a skin-test reactor. Sensitivity to *F. tularensis* in more than one family member was found in two sheep-ranching families.

A history of clinically diagnosed tularemia was elicited from only four reactors. Infection had occurred from 3 to 30 years previously, following tick bites or while the person was directly engaged in sheep-ranching activities. Among the 20 reactors with unrecognized infection, nine had febrile illnesses associated with

Table 2. Frequency of skin-test reaction, by sex and age group, Garfield County tularemia survey, 1967

Age (years)	Male			Female			Total		
	Number tested	Reactors		Number tested	Reactors		Number tested	Reactors	
		Number	Percent		Number	Percent		Number	Percent
Total.....	194	19	9.8	171	5	2.9	365	24	6.6
Less than 20.....	83	3	3.6	59	2	3.4	142	5	3.5
20-39.....	36	2	5.6	44	0	0	80	2	2.5
40-59.....	60	13	21.7	52	3	5.8	112	16	14.3
60 and over.....	15	1	6.7	16	0	0	31	1	3.2

Table 3. Frequency of skin-test reaction, by occupational exposure and age group, Garfield County tularemia survey, 1967

Age (years)	Sheep contact ¹			No sheep contact		
	Number tested	Reactors		Number tested	Reactors	
		Number	Percent		Number	Percent
Total.....	211	20	9.5	154	4	2.6
Less than 20.....	75	3	4.0	67	2	3.0
20-39.....	43	2	5.0	37	0	0
40-59.....	78	15	19.0	34	1	3.0
60 and over.....	15	0	0	16	1	6.0

¹ Worked directly with sheep or lived on sheep ranch.

lambling or shearing activities, one had a tularemia-like illness not known to be sheep or tick related, and 10 had no history of illness. The last group included four men, all sheep ranchers, three other males living on a sheep ranch (two of whom were teenagers), and three who had no direct contact with sheep. One female non-reactor reported that she had tularemia 10 years earlier, but the illness had not been serologically confirmed.

Figure 2 shows the distribution of skin-test reaction sizes. Among reactors, 7 millimeters of induration was the least and 20 millimeters the greatest. Mean reaction size was 13.1 millimeters of induration, which compares favorably with sensitivity reaction sizes in an earlier study of Montana trappers and tularemia cases (1).

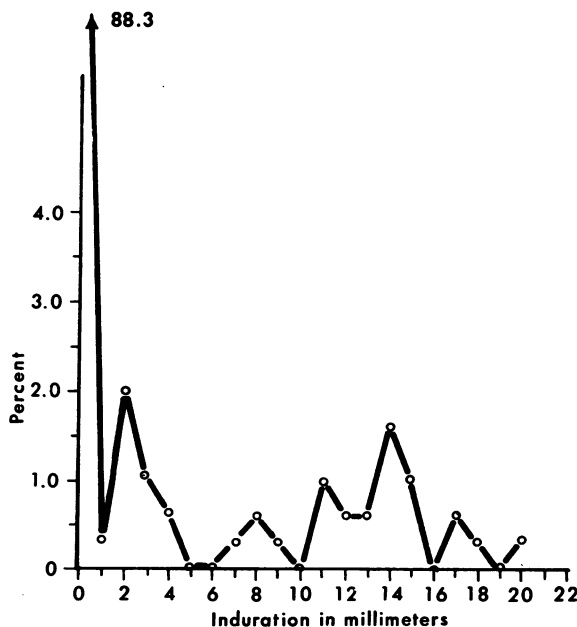
Discussion

Sensitivity and specificity of the skin test to identify missed or inapparent infections has been discussed (1). Dermal sensitivity from clinical infection persisted for many years. Our survey provides additional information on the usefulness of the skin test. In an area where tularemia is a problem, this test can provide reliable information on the prevalence of past infection.

Although clinical tularemia has been diagnosed and reported consistently in Garfield County by one physician, the number of reported cases has not reflected the true incidence of tularemia infections. In the outbreak that occurred in 1964, four of the 12 patients did not seek medical care and would have been missed if a special effort had not been made to find additional infections. Also in 1964, in a selective serologic sampling of 67 persons having a history of diagnosed tularemia or tularemia-like illness or who worked with sheep, 27 had tularemia agglutinins. This serologic-positive group included the 12 persons with cases diagnosed in 1964, nine persons with a history of tularemia occurring before 1964, and six persons with no history of a tularemia-like illness. Twenty-three of the 27 persons with agglutinins in 1964 did not participate in the 1967 survey.

By combining the results of the two surveys, a total of 47 persons could be identified as having past infections, or 2.4 percent of the county

Figure 2. Percentage distribution of tularemia skin-test reaction sizes, Garfield County, 1967



population. In the skin-test survey, 24 persons reacted to *F. tularensis*, only four of whom had previously diagnosed tularemia infections. If the population tested was representative of the total population, the true incidence of past tularemia infection in Garfield County was five times higher than reported.

Previously reported cases, as well as the results of this survey, indicate that tularemia in Garfield County is predominantly an infection of adult male sheepworkers. Illness, even if mild, can interfere with the performance of ranching duties, and serious illness (for example, among sheepshearers) can jeopardize the economic advantage of an entire season. In areas where the opportunity for infection from tick vectors is high, a risk of tularemia is sufficient to warrant consideration of preventive vaccination for sheepworkers.

Summary

Three hundred and sixty-five persons from sparsely populated, sheep-ranching Garfield County in eastern Montana were skin tested for sensitivity to *Francisella tularensis*. Twenty-four persons (6.6 percent) were reactors: 19 (10 percent) of 194 males and five (3 percent) of

171 females. Only four reactors had a history of prior tularemia infection.

Although clinical tularemia had been consistently diagnosed and reported in Garfield County, the true incidence of tularemia infections had not been reflected. Most infections were unrecognized or subclinical. Tularemia skin tests were useful for determining the prevalence of infection in this county, and evidence of the risk of tularemia is sufficient to warrant consideration of preventive vaccination of sheepworkers.

REFERENCES

- (1) Philip, R. N., Casper, E. A., and Lackman, D. B.: The skin test in an epidemiologic study of tularemia in Montana trappers. *J Infect Dis* 117: 393-402, December 1967.
- (2) Jellison, W. L., and Kohls, G. M.: Tularemia in sheep and in sheep-industry workers. PHS Publication No. 421 (Public Health Monograph No. 28). U.S. Government Printing Office, Washington, D.C., July 1955.
- (3) Larson, C. L.: Immunization of white rats against infections with *Pasteurella tularensis*. Public Health Rep 60: 725-734, June 29, 1945.
- (4) U.S. Bureau of the Census: Census of population: 1960. General population characteristics. Montana. Final report PC(1)-28B. U.S. Government Printing Office, Washington, D.C., 1961.
- (5) Philip, R. N., Huntley, B., Lackman, D. B., and Comstock, G. W.: Serologic and skin test evidence of tularemia infection among Alaskan Eskimos, Indians and Aleuts. *J Infect Dis* 110: 220-230, May-June 1962.

Migrant Health Grants Awarded

Eighteen migrant health projects, located in 11 States, have been awarded grants totaling about \$500,000 from the Public Health Service.

The grants, authorized by the Migrant Health Act, will be used to improve health services to migrant agricultural workers and their families. Funds will be used to provide medical and dental care, supported by field nursing and sanitation services, health education, and in-hospital care.

The largest single grant, \$69,034, was awarded to the Skagit County Health Department, Mount Vernon, Wash. Two projects, in Paw Paw and Hoopes-ton, Ill., received grants for the first time. Four projects in Texas, a home-base area for many migrant workers, were awarded a total of \$147,276.

There are now 118 projects making family health services available to migrant workers in more than 300 counties in 36 States and Puerto Rico. Grants are made to State and local public agencies and to nonprofit private organizations which are required to contribute part of the cost of the projects.

Following is a list of the projects and amounts of the grants.

<i>State and recipient</i>	<i>Amount</i>
Connecticut:	
Connecticut State Department of Health--	\$6, 032
Idaho:	

Idaho Department of Health-----	29, 244
Illinois:	
Hoopeston City Migrant Council-----	6, 400
Lee-Ogle Counties Migrant Council	
(Paw Paw)-----	9, 131
Princeville City Migrant Council-----	2, 655
Illinois Department of Health-----	15, 313
Indiana:	
Indiana State Board of Health-----	42, 274
Iowa:	
Migrant Action Program (Mason City) --	27, 744
Maryland:	
Wicomico County Health Department----	9, 686
Nebraska:	
Nebraska Department of Health-----	43, 815
Ohio:	
Wood County Health Department-----	22, 310
Darke County General Health District--	17, 446
South Carolina:	
South Carolina State Board of Health	
(Beaufort County)-----	30, 446
Texas:	
Castro County Commissioner's Court--	46, 058
Floyd County Commissioner's Court----	38, 042
Jim Hogg County Commissioner's Court--	17, 413
La Salle County Commissioner's Court--	45, 763
Washington:	
Skagit County Health Department-----	69, 034

Education Notes

Care of Premature and Other High-Risk Infants.

The institutes for physicians and nurses in the care of premature and other high-risk infants at the New York Hospital-Cornell Medical Center, sponsored by the New York State Department of Health and the U.S. Children's Bureau, will begin their 21st year in the fall of 1969. The institutes are designed to meet the needs of physicians and nurses in charge of hospital nurseries for high-risk and premature infants and special centers for infant care and of medical and nursing directors and consultants in State and local programs for the care of such infants.

Five institutes are scheduled between September 1969 and May 1970. The sessions are 2 weeks for physicians and 4 weeks for nurses.

Physicians

September 22–October 3

November 10–21

January 19–30

March 16–27

May 18–29

Nurses

September 8–October 3

October 27–November 21

January 5–30

March 2–27

May 4–29

Attendance at each institute is limited to six physicians and six nurses. Early application for the institutes is essential because plans are contingent on the number of applications received.

Participants pay no tuition, and stipends are provided to cover other expenses. For additional information write to Box 143, Institutes in the Care of Premature and Other High-Risk Infants, New York Hospital, 525 East 68th Street, New York, N.Y. 10021.

Western Institute of Drug Problems. The second annual summer school of the Western Institute of Drug Problems will be held on the campus of the Portland (Oreg.) State University, August 11–15, 1969.

The course, directed to professionals and students in all disciplines, will deal with the nature, prevention, and control of drug abuse and the treatment of drug-dependent persons. *General sessions* will present historical, sociocultural, medical, economic, and other fundamental aspects of drug problems. *Interdisciplinary sessions* will be designed to stimulate the exchange of information concerning drugs and drug-related problems among various special interest groups. *Specific group sessions* will provide an op-

portunity for persons with special interests, background, or professional training to discuss drug problems in relation to their activities.

Undergraduate, graduate, and professional (non-college) transcript credit is available. American Academy of General Practice credit, category one, may be applied for.

The \$55 registration fee covers admission to general sessions and participation in interdisciplinary and special group sessions, class materials, prepared library materials, and transcripts of professional papers. Requests for the limited number of scholarships are handled in order of application.

Information about housing is available on request. Reservations should be arranged directly with whatever facility the applicant chooses.

Additional information is available from the Administrator, Summer School, Western Institute of Drug Problems, Post Office Box 4372, Portland, Oreg. 97208.

Regional Planning Program. The University of Michigan's School of Natural Resources offers a program leading to a master of regional planning degree.

The purpose of the program is to train students for careers of broad scope and responsibility in both the public and private sectors—emphasizing policies and programs, cities, resources, and public facilities. The 2-year curriculum covers application of problem-solving methods to relationships among natural and human ecological, technological, and politico-economic systems.

Students must have a bachelor's degree from an accredited college or university and submit an official transcript showing all academic work completed. Undergraduate studies in natural resources, geography, economics, political science, sociology, landscape architecture, planning, architecture, or engineering are particularly appropriate. Students from other disciplines, with special analytic skills or with substantive knowledge or interests may also apply.

Fellowships up to \$1,700, graduate assistantships of \$1,000 per term, and research assistantships up to \$3,250 are available. Formal application with application fee must be submitted 2 months before enrollment.

Additional information is available from the Chairman, Regional Planning Program, School of Natural Resources, University of Michigan, Ann Arbor, Mich. 48104.